

## NOTES

### ATLANTIC THREAD HERRING (*OPISTHONEMA OGLINUM*) - MOVEMENTS AND POPULATION SIZE INFERRED FROM TAG RETURNS

Atlantic thread herring, *Opisthonema oglinum* (Lesueur), occur from Massachusetts southward along the Atlantic coast of the United States, throughout the Gulf of Mexico, and into the Caribbean (Berry and Barrett, 1963; Reintjes and June, 1961). In the South Atlantic area this species is occasionally caught by purse seine vessels fishing for menhaden, *Brevoortia tyrannus*. In the period 1968 through 1970 the catch of thread herring in the South Atlantic averaged 2,000 metric tons. Thread herring have been considered a potential supplement to the declining menhaden catch on the Atlantic coast, although very little is known about population size, distribution, or movement of this species.

The primary objective of this study was to determine if the thread herring population is large enough and is distributed widely enough to provide an alternate resource for the Atlantic menhaden fishery. In September 1968, we tagged 1,582 thread herring about 1 mile off the North Carolina coast: 299 approximately 2 miles west of Beaufort Inlet and 1,283 approximately 5 miles east of Bogue Inlet (Figure 1).

Tags were recovered on magnets at menhaden processing plants during the manufacture of fish meal. Magnets had been installed earlier at all of the plants for recovery of steel tags placed in menhaden. Primary magnets are located in the plant conveyor system between the fish scrap driers and the scrap storage shed. Almost all tags pass over these magnets the same day fish are processed. Secondary magnets were located at other positions in the conveyor system and may not recover tags until months after the fish are landed when the scrap is ground into meal or is shipped from the plant.

Test tags were placed in dead fish entering the plant to determine recovery efficiencies. Each

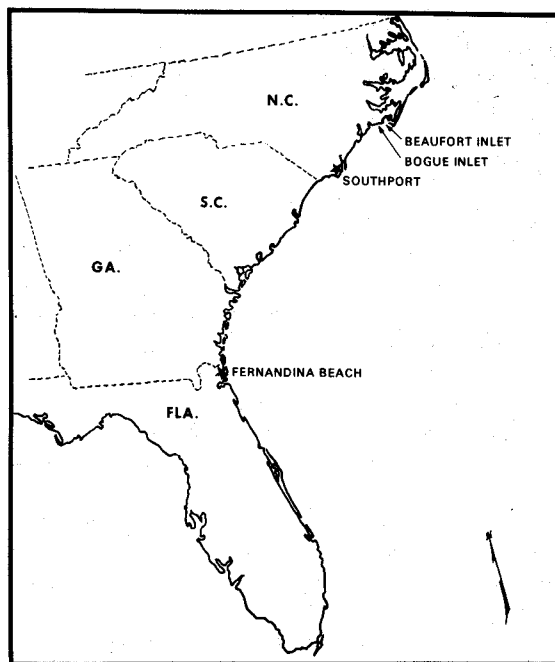


FIGURE 1.—South Atlantic coast of the United States showing areas of tag release and recovery.

week 100 tags were put into fish at each plant, and recoveries throughout the season from these tests were averaged to determine the plants' recovery efficiency.

#### Recovery Efficiencies

Average recovery efficiencies were calculated for each recovery area by recovery year. The following formula was used to determine recovery efficiency for each test:

$$\text{Recovery efficiency} = \frac{\text{Number of test tags recovered}}{\text{Number of test tags released}}$$

#### Methods and Materials

The tags and methods currently being used to tag menhaden were applied to thread herring.

A manually operated gun with a magazine holding 100 tags (14 mm  $\times$  3 mm  $\times$  0.5 mm) was used to insert the tags. Individually numbered tags enabled us to determine species, date, and location tagged, and date and location recovered. The gun was designed so that approximately 5 mm of the tag protruded from its barrel. The incision for inserting the tag was made by pushing the tag through the body wall. By holding the end of the barrel against the fish and depressing the plunger, a tag was inserted approximately 5 mm through the body wall into the body cavity (Figure 2). Tests were not performed to determine tagging mortality. However, experiments on menhaden indicate a tagging mortality—tag shed rate of 10-20% for fish over 110 mm having this tag.<sup>1</sup>

Thread herring were tagged aboard menhaden carrier vessels. Fish were dipped from the purse seine, placed in live boxes (2 ft  $\times$  2 ft  $\times$  4 ft) supplied with running seawater, tagged, and immediately released overboard. Each box held 200-500 thread herring (average 150 mm fork length) for as long as 45 min. Fish did not exhibit overexcitement or die when held in these numbers. Water temperature was 23°C. Average recovery efficiencies and the range of efficiencies are shown for each recovery area by year in Table 1. All recovery efficiencies were calculated from recoveries on primary magnets except the Fernandina Beach, Fla., area in 1968. Only one tag was recovered there on a secondary magnet. Using the average recovery efficiencies,

<sup>1</sup> Kroger, R. L., and R. L. Dryfoos. Preliminary tagging and tag-recovery experiments with Atlantic menhaden, *Brevoortia tyrannus*. Manuscript in preparation. National Marine Fisheries Service, Atlantic Estuarine Fisheries Center, Beaufort, NC 28516.

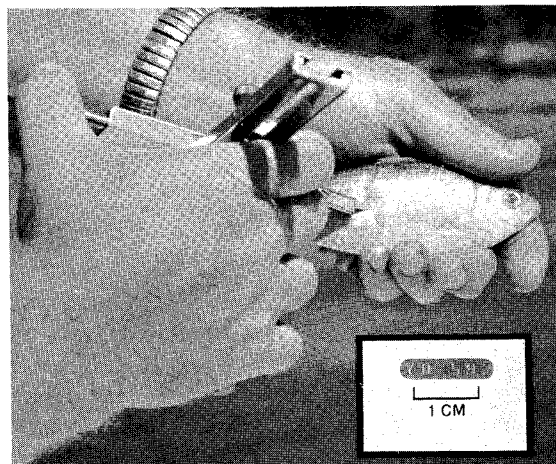


FIGURE 2.—Close-up of thread herring being tagged. Inset: Stainless steel tag.

we estimated the total number of tagged fish recaptured from our field tagging (Table 2).

### Movements

Directions of the movements of fish were determined from recaptures of tagged thread herring (Figure 3). In the South Atlantic the menhaden fishing fleets operate near the processing plants, and catches are landed on the same day they are caught. A daily inspection of magnets enabled us to determine the area and date of tag recapture.

In 1968 an estimated 92 tagged fish were recaptured. Twelve of these tagged fish were recaptured near Southport, N.C., about 75 miles south of the release site within 25 days after release. Two months after release, the fish had migrated about 370 miles south to Fernandina

TABLE 1.—Tag recovery efficiencies by year and location where tagged thread herring were recovered, 1968-70.

Recovery year	Recovery location							
	Chesapeake Bay, Va.		Beaufort, N.C.		Southport, N.C.		Fernandina Beach, Fla.	
	Average	Range	Average	Range	Average	Range	Average	Range
	Percent recovery							
1968	No recoveries		52	47-65	67	60-78	33	28-62
1969	67	25-81	49	36-72	77	46-98	22	5-67
1970	No recoveries		No recoveries		70	46-92	No recoveries	

TABLE 2.—Actual and estimated numbers of tagged thread herring recaptured, 1968-70, from 1,582 releases near Beaufort, N.C., September 1968.

Recovery date	Recovery location							
	Chesapeake Bay, Va.		Beaufort, N.C.		Southport, N.C.		Fernandina Beach, Fla.	
	Actual	Estimated	Actual	Estimated	Actual	Estimated	Actual	Estimated
	No.	No.	No.	No.	No.	No.	No.	No.
1968								
September			39	75				
October			1	2	8	12		
December							1	3
1969								
May					1	1		
July	1	2						
September			7	14	8	11		
October					7	9		
November							2	9
December			1	2				
1970								
October					3	4		

Beach, as indicated by the estimated recapture of three fish there. The Florida recaptures were made prior to November 15, the last day thread herring were caught. The tags were recovered in December on a secondary magnet.

In the spring of 1969 no thread herring were landed. The single recovery in Southport was most likely a holdover from the previous season. There was no offshore spring fishery near Beaufort; thus no possibility of recoveries there.

The recaptures in Chesapeake Bay, Va., came from fish that could have been caught off the northern coast of North Carolina and transport-

ed to the Bay as some Chesapeake Bay vessels fished off the North Carolina coast during that period. The plant did not report any thread herring landings, so the thread herring probably were mixed with menhaden.

In the autumn of 1969 tagged thread herring were recaptured sequentially along the South Atlantic coast from Beaufort to Fernandina Beach, again indicating a southerly fall migration. An estimated 16 were recaptured in September at Beaufort, 20 in September and October at Southport, and 9 in December at Fernandina Beach. The December recoveries at Beaufort are the result of tags probably lodged in the conveyor system because thread herring were landed only in September.

In 1970 thread herring were landed only during the autumn. Four fish were estimated recaptured at Southport in October. There was no fishing at Fernandina Beach in late October and November when thread herring are usually caught in that area.

Results from this experiment indicate that thread herring migrate south in the autumn along the South Atlantic coast (Figure 3). Southerly migration rates were estimated from elapsed time and distance between areas. In 1968, about 10 days after release, several tagged fish were recaptured near Cape Fear, N.C., 75 miles south of the tagging site. An additional recapture was made about 370 miles south off

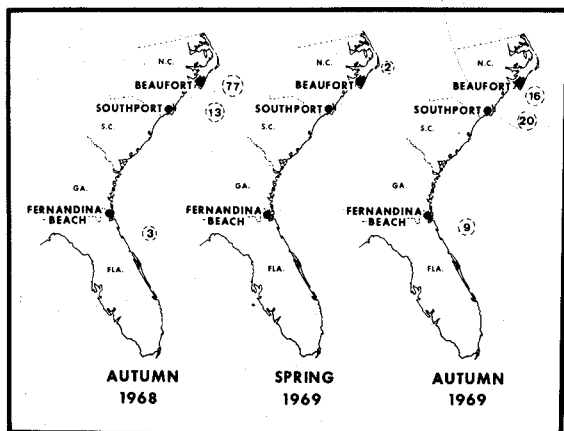


FIGURE 3.—Southerly movements of Atlantic thread herring along South Atlantic coast of the United States, 1968-70.

Florida within 53 days after release. The average distance traveled each day from Beaufort to Cape Fear and from Beaufort to Florida was 7.0 miles. In 1969 elapsed time between first recaptures at Beaufort and Florida was 56 days, resulting in an average distance traveled of 6.6 miles per day. From Southport to Florida, the elapsed time was 48 days or 6.1 miles per day. From these recoveries, we estimate that thread herring migrate south in fall at a rate of 6 to 7 miles per day.

### Population Size

An estimate of the size of the thread herring population moving south from Beaufort to Southport, in September 1968, can be made using the number tagged (less those recaptured before leaving the Beaufort area), the estimated number recaptured at Southport, and the catch at Southport (Table 3). An estimate of population size from our tagging data requires the assumption that the entire population moves as a group. That assumption is supported by the fact that tagged fish were recaptured with almost all thread herring catches.

For this estimate we are given (Ricker, 1958):

$C$  = Number of thread herring landed at Southport.

$M$  = Effective number of tagged fish at large.

$R$  = Estimated number of tagged fish recaptured at Southport.

$\hat{N}$  = Estimated population size.

then,

$$\hat{N} = \frac{M(C+1)}{R+1}$$

or

$$\begin{aligned}\hat{N} &= \frac{(1,505)(6,535,583)}{14} \\ &= 702.6 \text{ million fish} \pm 355.6 \text{ million} \\ &\quad (95\% \text{ confidence interval})\end{aligned}$$

This estimate, made so soon after tagging, could be misleading. No adjustment is possible for the degree of mixing of tagged with untagged

TABLE 3.—Thread herring landings and estimated number of tags recovered by area from 1968-70.

Area	1968	1969	1970
Chesapeake Bay, Va.			
Number of fish landed	0	10	0
Number tags recovered	0	2	0
Beaufort, N.C.			
Number of fish landed	14,385,394	15,737,303	8,259,404
(metric tons)	(849.4)	(898.6)	(453.4)
Number tags recovered	77	16	0
Southport, N.C.			
Number of fish landed	6,535,582	19,548,161	34,383,824
(metric tons)	(385.9)	(1,116.2)	(1,887.5)
Number tags recovered	13	20	4
Fernandina Beach, Fla.			
Number of fish landed	5,275,548	2,367,776	20
(metric tons)	(311.5)	(135.2)	
Number tags recovered	3	9	0

<sup>1</sup> None of the landings were reported as thread herring.

<sup>2</sup> Fishing terminated early in October before thread herring normally are caught in area.

fish in the population. Fishing at Southport may have been concentrated on the tagged portion of the population. No adjustment was made for tag loss from shedding and mortality. These effects would produce an underestimate of the stock size. On the other hand, this calculation might overestimate population size because we were unable to determine rate of recruitment.

The one tag recovery from Florida was not used to estimate population size. A single recovery and a low magnet efficiency provide an imprecise estimate of recaptures.

Another estimate can be made using the recoveries and landings from September through November 1969. In this case, sufficient time elapsed for mixing of tagged fish in the population, but tag loss or recruitment were not taken into account. In this estimate:

$$\begin{aligned}\hat{N} &= \frac{(1,487)(37,653,241)}{46} \\ &= 1,217.2 \text{ million fish} \pm 355.1 \text{ million} \\ &\quad (95\% \text{ confidence interval})\end{aligned}$$

We feel these estimates, although very gross, are indicative of the population size for the purpose of this study. The catch of thread herring in 1968 was approximately 1,547 metric tons and in 1969 was 2,150 metric tons (Table 2), while in 1968 and 1969 the average catch of men-

haden in the South Atlantic summer fishery alone was 34,435 metric tons.

Estimates of the thread herring population size expressed in metric tons equal approximately  $45,000 \pm 23,000$  in 1968 and  $71,000 \pm 21,000$  in 1969. The 95% confidence intervals suggest that true population size might vary from 22,000 to 92,000 metric tons. Thus, the thread herring resource appears capable of supporting a larger fishery at this time since not more than 10% of the population was harvested in 1968 or 1969, but it does not appear to have the capacity to offer an alternate resource for the Atlantic menhaden fishery. Thread herring distribution is generally limited to the South Atlantic area, whereas Atlantic menhaden are distributed along most of the Atlantic coast of the United States. A 50% harvest rate, at most, would amount to little more than the present menhaden landings in the South Atlantic summer fishery.

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